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DO B CHROMOSOMES AFFECT FECUNDITY IN YELLOW-NECKED MICE *APODEMUS FLAVICOLLIS* (RODENTIA, MAMMALIA)?

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Abstract - The effects of the presence of B chromosomes on fecundity of the yellow-necked mouse *Apodemus flavicollis* were studied in 46 females without and 28 with Bs from four localities in Serbia. Uterine inspection showed that there was no significant difference in the mean number of scars and embryos between females with and those without Bs. Thus, B chromosomes do not appear to affect the fecundity of females carrying them, indicating that the presence of Bs does not affect fitness characteristics.

Key words: B chromosomes, fecundity, heterotic model

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INTRODUCTION

Chromosomes of the B type (Bs) are present in about 15% of species of almost all taxa (J o n e s, 1985). Maintenance of Bs is a matter of long-lasting discussions postulating either of two opposed models. The first, named the parasitic model, explains their maintenance as a balance of opposing forces of accumulation versus elimination of Bs, which are generally detrimental (Ö s t e r g r e n, 1945). The existence of any mechanism of accumulation is *sine qua non* for the parasitic model. The second model, designated heterotic, sees the maintenance of Bs as an equilibrium between the advantage of a small number of Bs to their carrier and the detrimental effects of a larger number (W h i t e, 1973). As the effects of Bs are, except in a few cases, not phenotypically visible, making the search for their effects very laborious, dominance is lent brought to the parasitic explanation. Even in cases were no accumulation mechanism was found, maintenance of Bs is explained as a transient stage of previously parasitic Bs (C a m a c h o *et al.,* 1997). On the other hand, some more extensively studied cases show that Bs could confer advantages to their carriers.

The genus *Apodemus* is rich in species with Bs (Z i m a and M a c h o l á n, 1995; K a r t a v t s e v a, 2002; V u j o š e v i ć and B l a g o j e v i ć, 2004; W ó j c i k *et al.*, 2004), among which *A. flavicollis* and *A. peninsulae* have been studied in detail. For *A. flavicollis,* which is the subject of this study, the following is known:

1. Chromosomes of the B type are present in almost all populations in frequencies of from 0.11 to 0.96 (V u j o š e v i ć *et al.*, 1991; Z i m a and M a c h o l á n, 1995; K a r t a v t s e v a, 2002);

2. An equilibrium in the frequency of Bs is present year after year (V u j o š e v i ć, 1992), but variability during the year is sometimes significant (B l a g o j e v i ć and V u j o š e v i ć, 1995; V u j o š e v i ć and B l a g o j e v i ć, 1995);

3. The absence of a mechanism of accumulation of Bs in *A. flavicollis* was confirmed in males (V u j o š e v i ć *et al*., 1989), but its lack in females was predicted from indirect evidence only.

4. A correlation of the frequency of animals with Bs and climatological variables is established (V u j o š e v i ć and B l a g o j e v i ć, 2000);

5. Significant effects on some biometric phenotypic features have been revealed (Z i m a and M a c h o l á n, 1995; Z i m a *et al*., 2003; B l a g o j e v i ć and V u j o š e v i ć, 2000, 2004; B l a g o j e v i ć *et al*., 2005);

6. The presence of characteristic DNA sequences and differential expression of some genes has been scored in animals with Bs (T a n i ć *et al.,* 2000, 2005).

With this in mind, it was interesting to explore if the presence of Bs affects the fecundity of females of *A. flavicollis*.

MATERIAL AND METHODS

Seventy four females included in the study were collected from four populations in Serbia (Mt. Cer - CQ84, 15 animals; Mt. Avala - DQ64, 40 animals; Košutnjak – DQ55, six animals; Mt. Fruška Gora – DR00, 13 animals). Chromosomes were prepared using standard procedures and 30 metaphase figures were analyzed to detect the presence of B chromosomes. All specimens possessing more than 48 chromosomes (standard set) were assumed to have Bs (B+). The maximal number of Bs in the karyotype was used as the parameter for classifying B+ animals into two groups: group 1B and a group with more than one B (>1B).

Females were dissected for uterine inspection. The number of implanted embryos and number of births from old and recent placental scars (*maculae cyanosae*) on the uterus were calculated. In pregnant females the number of embryos in the uterine branches was also taken into account. As the age parameter we used dry eye lens weight for each specimen, estimated by the method of L o r d (1959). In order to eliminate the effects of age on the number of scars and embryos we used dry eye lens weight as covariant in One Way ANCOVA.

RESULTS AND DISCUSSION

The average frequency of females with Bs in the whole analyzed sample was 0.39. Among animals with Bs there were 75% with one B, 21.4% with two Bs, and only 3.6% with three. The results of uterine inspection, given in Table 1, show that there was no significant difference in the mean number of scars and embryos (One Way ANCOVA: $F_{(2,68)} = 0.19$, $p = 0.83$) among the analyzed groups (without Bs, with one B, and with more than one B chromosome).

Fecundity represents the potential rate at which an organism reproduces. In vertebrates, it is usually measured as the number of offspring produced by a female each year. The results obtained show that the presence of Bs does not affect fecundity significantly. However, the number of scars and embryos was increased in females with one B chromosome in relation to both other groups (without Bs and with more than one B chromosome). Z i m a and M a c h o l á n (1995) found that average litter size did not differ significantly between females of *A. flavicollis* with and without Bs in the Czech Republic. The heterotic model of maintenance of Bs assumes a balance between the positive fitness effects of Bs (which show no accumulation) when they occur in low numbers and their negative effects when they occur in high numbers. Our results indicate that the presence of a small number of B chromosomes not only does not make any disturbance in the fecundity of their carriers, but when one B chromosome is present it could also confer some benefit by increasing fecundity. This result, together with previous findings about the effects of Bs (B l a g o j e v i ć and V u j o š e v i ć 2000, 2004; Z i m a *et al*., 2003), supports the heterotic explanation of maintenance of Bs in populations of *A. flavicollis*.

Table 1. Mean value of uterine scars and embryos in groups without (B0) and with 1B and 2B chromosomes in females of *Apodemus flavicollis*

	n	Mean±SD
B0	46	6.59±3.34
1B	21	7.14±3.80
>1B	7	6.86±2.04
Total	74	6.74±3.35

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ДА ЛИ В ХРОМОЗОМИ ДЕЛУЈУ НА ФЕКУНДИТЕТ КОД ЖУТОГРЛОГ МИША *APODEMUS FLAVICOLLIS* (RODENTIA, MAMMALIA)?

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В хромозоми су додатни хромозоми у односу на стандардни комплемент и нису неопходни за преживљавање. Јављају се у готово свим таксонима код око 15% врста. Одржавање В хромозома објашњава се, у паразитском моделу, као баланс супротних деловања механизама акумулације и елиминације. У хетеротичном моделу, равнотежа се постиже захваљујући позитивним ефектима малог броја В хромозома.

У овом раду испитивани су ефекти присуства В хромозома на фекундитет жутогрлог миша, *Apodemus flavicollis,* и то код 46 женки са и 28 без В хромозома са 4 локалитета у Србији. Анализа утеруса показала је да нема значајних разлика у просечном броју ожиљака и ембриона међу јединакама са и без В хромозома. Према томе, В хромозоми немају ефекте на фекундитет женки које су носиоци, односно њихово присуство не делује на ову значајну фитнес карактеристику. Претходни налази, заједно са нашим резултатима, подржавају хетеротички модел одржавања В хромозома код анализиране врсте.